CLOSURE OR STOPPER FORMS A SURFACE TENSION SEAL.

Field of the Invention

This invention relates to closures or stoppers for containers containing liquid, powder or pastes, particularly wine bottles.

Background of the Invention

A major technical issue in the wine industry is the unpredictable incidences of problems that occur once the wine has been bottled due to the properties of the closures used.

Traditional cork closures have problems with taint, caused in a major part by Trichloroanisoles (TCA), known more commonly as corked taint or causing "corked wine". It has been estimated that the wine in up to 10% of all bottles of wine produced worldwide may be affected in this manner. A more recently recognised problem with using cork as a closure is the physical nature of cork having variability to the permeation of oxygen which can lead to inconsistent and uneven development of the bottled wine. Leakage has always been an issue associated with cork caused by a fault line or lines or porosity in the cork.

The continued and increasing dissatisfaction amongst wine makers with the performance of natural cork as a closure has led to some use of synthetic material and varying forms of approach such as the screw top "STELVIN™" cap. There have been issues of taint and other performance issues from synthetic materials and the screw type closures and there is limited experience and testing of the performance of these materials. There is also considerable market resistance to the use of synthetic

materials.

Summary of the Invention

According to a first aspect of the present invention there is provided a closure for a container arranged to contain liquid, powder or paste, the container comprising means to define a first extremely flat surface, a sealing member defining a second extremely flat surface, the extremely flat surfaces adapted to form a surface tension seal when they are pressed into parallel abutting contact and means to prevent lateral relative movement whereby the sealing member prevents escape of liquid, powder or paste from the container.

The first surface may be formed on the container or on a component attached to the container. The closure may also include means to urge the extremely flat surfaces into parallel abutting contact.

In accordance with the second aspect of the present invention there is provided a closure for a wine bottle having a neck and an aperture, the closure comprising a first extremely flat surface around the neck of the bottle, a sealing member having a second extremely flat surface, the sealing member being adapted to fit onto the first surface and across the aperture with the second surface in parallel abutting contact to form a surface tension seal, and means to prevent relative lateral movement of the surfaces.

The first extremely flat surface may be defined by the neck of the bottle, preferably the top section or an opening defined at the neck. The sealing member may be a disc of glass, ceramic, carbon, metal carbide, metal oxide or other hard materials that can define a flat surface. Preferably a removable member locates the

sealing member laterally of the first surface. The closure may also include means to urge the surfaces into parallel abutting contact.

An extremely flat surface is understood to embrace a surface that is finished with a roughness low enough (level of polish) to ensure a liquid-tight seal (that totally prevents escape of the liquid from the container) at maximum differential pressure allowed for the container. At the same time the roughness (level of polish) of the flat surface can be designed to create an airtight seal (hermetic seal) or to create air permeable seal (breathing seal) at specified pressure conditions inside the container. It is understood that the differential pressure allowed across the seal will be related to the degree of downward force urging of the surfaces into parallel abutting contact. In a preferred embodiment where the liquid is wine the surface is finished to have optical flatness to a few wavelengths of light. The surfaces are preferably provided on glass sintered ceramic, carbon, metal carbide, metal oxide or other hard materials which are inert to the materials it contains.

In one embodiment the sealing member will have a degree of porosity to ensure restricted entry of air to allow the wine to breathe. The breathability could relate to the material per se or use of a porous plug in the material or the level of finish of the sealing surfaces and the pressure of surface to surface contact.

Brief Description of Drawings

Embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings in which:-

Figure 1(a) is a side elevation view of a wine

bottle with a closure having an internal screw thread,

Figure 1(b) is a cross section view of the bottle taken along the lines L-L of Figure 1(a),

Figures 1(c) and 1(d) are a perspective view and cross sectional view of the closure,

Figures 2(a) and 2(b) are perspective and sectional views of a closure with an internal screw thread and insert,

Figures 3(a) and 3(b) are similar illustrations of a closure with an internal screw thread and internal sealing surface,

Figures 4(a) and 4(b) are similar illustrations of a closure secured in position by an external cap,

Figures 5(a) and 5(b) are similar illustrations of a closure that incorporates a domed projection through the cap,

Figures 6(a) and 6(b) are similar illustrations of a closure that has an external screw threaded cap,

Figures 6(c) and 6(d) are perspective views of modified caps,

Figures 7(a) and 7(b) are perspective and cross sectional views of an externally mounted screw top closure,

Figures 8(a) and 8(b) are perspective and sectional views of a screw closure that incorporates a spring washer,

Figures 8(c) is an exploded view of the closure of Figure 8(b),

Figure 8(d) is a perspective view of the underside of the cap of Figure 8(c),

Figures 9(a) and 9(b) are perspective and sectional views of a screw closure with an inbuilt spring washer,

Figure 9(c) is a perspective view of a sealing disc of the closure,

Figure 9(d) is a sectional view of the closure of Figure 9(b) with a porous insert,

Figures 10(a) and 10(b) are respectively elevational and cross-sectional views of a closure that includes a push-on outer sleeve in an open configuration,

Figures 10(c) and 10(d) are elevational and cross section views of the closure in a closed sealed configuration,

Figures 11(a) and 11(b) are a perspective and sectional view of a closure incorporating an outer collar and spring cap in an open configuration,

Figures 11(c) and 11(d) are perspective and sectional views of the closure in a closed sealed configuration, and

Figure 12 is a perspective view of a closure using a wire cap.

Description of the Preferred Embodiments

The embodiments of the invention described hereunder with reference to the accompanying drawings, all relate to closures for liquid containers and especially wine bottles. In essence the sealed closure is performed by the abutting contact between two extremely flat and smooth surfaces that are pressed into engagement to form a shear seal. All the embodiments include means to urge the surfaces into parallel abutting contact and to laterally locate the flat surfaces to prevent the seal being broken.

The abutting flat surfaces are extremely flat with the flatness being in the order of a few wavelengths of light. The wavelength of light in the visible spectrum range is between about 400 nanometres for deep violet and about 700 nanometres for deep red. A nanometre is a billionth of a metre. The flat surfaces that form the shear seals may be formed in glass with one portion defined by a hardened coating on the bottle itself and the other portion being defined by a glass or other hard material sealing member. In other embodiments suitable

inserts are provided in the bottle and the sealing member seals against those inserts. The surfaces of the bottle and sealing members are either manufactured from hard materials such as sintered ceramics that are lapped and polished to the desired flatness and surface finish, or alternatively the glass itself can be lapped and polished to the desired flatness and surface finish.

Shear seals operate by pressing two extremely flat surfaces together to evacuate the air between the surfaces with the resulting surface tension providing a seal that is strong in the axial direction. The seal can only be broken by either lateral relative displacement of the surfaces that shears the seal or by the application of a significant force in the axial direction i.e. perpendicular to the seal surface. Consequently in all of the embodiments described hereunder, means is provided to place the flat surfaces into parallel abutting contact under pressure. All of the seals also incorporate means to prevent lateral displacement of the surfaces and thus prevent the shear force that would break the seal.

In the embodiments described hereunder the same reference numerals are used for common features.

As shown in Figures 1(a) and 1(b) a wine bottle 10 has a main body 11 tapering upwardly to a neck 12. The neck has an opening 13 at the top that is sealed by a closure 20 that is a subject of this invention. The closure 20, shown in detail in Figures 1(c) and 1(d), essentially comprises a sealing member 21 that has a flat annular sealing surface or seat 22 that is arranged to be pressed into a parallel sealed engagement with a similarly profiled flat surface 23 on the top of the neck of the bottle. The flat surface 23 is known as the finish of the bottle. The sealing member 21 has a central downwardly extending core 24 with an outwardly projecting coarse

thread 25. The coarse thread can be coated with "giving" material that will not cause abrasion of the contacting surfaces. The thread is arranged to engage a similarly profiled coarse thread 26 formed on the interior surface of the interior of the top of the neck 12 of the bottle 10. The sealing member 21 can also include a small annular groove 29 that houses an O-ring 30 of rubber, plastics or cork. The O-ring 30 can be replaced by an annular membrane of rectangular cross section. The upper surface of the sealing member 21 defines a slightly convex crown 31.

As shown in Figure 1(c) the crown 31 may carry a trade mark and its periphery 32 may be knurled to assist purchase when the sealing member 21 has to be rotated relative to the bottle 10. To seal the bottle after it has been filled to the desired level, the sealing member 21 is simply screwed into the threaded interior 26 of the neck. The sealing member 21 is turned until the sealing surface 22 is into tight parallel abutting contact with the annular seat 23. The rubber, cork or composite O-ring 30 or like member provides a precaution against release by vibration and acts as a secondary backup seal. The threaded engagement between the core 24 of the sealing member 21 and the neck of the body is sufficiently coarse to provide a degree of clearance that allows the parallel abutting surfaces to come into positive infinite parallelism to effect the seal. The core is preferably of a material or coated in a material which is soft or giving in nature so that the interior of the bottle is not abraded and thus no debris falls into the container. The core 24 allows the parallel abutting surfaces to come into positive infinite parallelism to effect the seal.

To release the seal it is a simple matter to turn the sealing member 21 anti-clockwise to release the threaded engagement and break the seal. The combination

of the seal between the parallel abutting surfaces and the axial force required to break the seal coupled with the interconnection between the threaded core and the neck of the bottle ensures a totally efficient seal that can withstand vibration, noise and relative temperature fluctuations.

In the embodiment shown in Figures 2(a) and 2(b), the mouth of the neck of the bottle has a frustoconical cutout 40 with a triangular groove 41 towards the base. The cutout supports a similarly shaped insert 42 that is bonded to or moulded into the interior surface of the neck of the bottle. The insert provides an annular flat surface 44 on which the sealing member 21 is arranged to be in abutting sealed engagement when it is screwed into the neck of the bottle. As in the embodiment of Figures 1, the core 24 of the insert and the internal wall 27 of the bottle is internally threaded. An O-ring 30 of rubber, cork or composite or like member is also located in an annular groove 29 on the underside of the sealing surface to absorb vibration and act as a backup seal.

In the embodiment of Figures 3(a) and 3(b), the neck 12 of the bottle 10 has an internal undercut portion 50 that ends in an annular shoulder that defines the sealing surface 51 or finish on which the sealing member 21 engages. The sealing member is of cylindrical configuration with an external coarse thread 25 that mates with a similarly profiled thread 26 on the interior of the neck of the bottle. A rubber or cork O-ring 53 or like member locates between the top of the shoulder of the sealing member 21 to provide precaution against release by vibration. The sealing member is a screw fit into the threaded recess and is thus located from axial movement by the annular wall of the neck of the bottle. To release the seal an elongate cutout 55 is provided in the upper surface 56 into which a coin or screwdriver can be

inserted to effect anti-clockwise rotation of the sealing member to break the seal. This embodiment has the advantage that the sealing member 21 is protected from damage by the wall of the bottle. The whole of the sealing member is recessed into the top of the bottle.

In an embodiment (not shown) the construction is very similar to the embodiment of Figures 3 except that instead of using a polished surface of the bottle to support the seal a tapered recess of the kind described with reference to the embodiment of Figures 2 is incorporated into the neck of the bottle to support an insert that is bonded to the glass of the bottle. The insert provides the optically flat surface against which the sealing member engages.

In the embodiment illustrated in Figures 4(a) and 4(b) the external profile of the neck 12 of the bottle 10 has an annular land 65 that defines an undercut 64. A coarse external thread 63 is positioned above the land 65 and the top of the bottle known as the finish defines a flat annular sealing surface 67. The neck 12 is designed to accommodate a crimped metal foil cylindrical closure member 69 often referred to as a STELVIN™ or screw cap enclosure. The closure member 69 is rolled onto the neck of the bottle to form a coarse internal thread 61 and terminates in a closure band 62 that locates in the undercut 64. By rotating the top of the closure member 69 by the knurled exterior 32 shown in Figure 4(a) the foil of the closure band 62 is broken and the metal cap can be removed. The actual seal is effected through the interface between a disc like sealing member 66 that seats on the flat annular sealing surface 67 defined by the top of the neck 12 of the bottle. A rubber or cork ring or spring 68 sits on the exterior of the top of the sealing member 66 on the underside of the metal cap 65 to place the seal under axial load and protects the seal from

vibration.

In the embodiment shown in Figures 5(a) and 5(b) the sealing member 70 has a domed upper surface 71 that extends through 72 an aperture in the top of the metal closure 73. In all other respects the closure is the same as the embodiment of Figures 4.

In the embodiment of Figures 6(a) and 6(b) the metallic screw cap is replaced by a thicker plastics cap 80 that is in threaded engagement with the exterior of the neck of the bottle. To improve the aesthetics of the cap it is understood that it could be made in other suitable materials. The cap has an opening 81 through which the dome 71 of the sealing member 70 extends but the sealing member engages and seals with the top of the bottle as in embodiment shown in Figures 4 and 5. An annular cork or rubber ring 68, metal spring or wave washer locates under the top of the cap against the sealing member 70 to place the sealing member in axial compression against the top of the bottle.

In the embodiment shown in Figures 6(c) and 6(d), the cap 85 is not in screw threaded engagement with the exterior of the bottle but includes three equally spaced inwardly projecting lugs 86 that are adapted to slide down elongate channels in the exterior of the bottle and then engage on a shoulder defined by the annular recess 87 shown in Figure 6(b). In this manner, the cap can be slid down the grooves in the bottle and then turned to assume a locked position similar to that shown in Figure 6(b). The annular cork or rubber ring 68 is compressed when the cover 85 is in this position to pull the sealing member 70 into compression on the top of the bottle. The embodiment shown in Figure 6(d) is similar to that of Figure 6(c) except that the cap 85 has a skeletal or open walled structure.

In the embodiment shown in Figures 7(a) and 7(b) an external screw threaded closure 120 covers the top of the neck 12 of the bottle 10. The sealing member 121 is defined by the underside of a ceramic cap with a downward skirt 122 that terminates in a lip 124 that engages in a groove 125 in the bottle neck 12. The top of the bottle 10 defines an annular flat sealing surface 128 on which the sealing member seals. The inside of the cap has a coarse thread 129 that co-operates with a similar coarse thread 127 on the exterior of the bottle neck 12.

In the embodiment shown in Figures 8(a) to 8(d) the neck 12 of the wine bottle 10 terminates in an annular land 45, an external coarse screw thread 63 and a substantially flat annular sealing surface 67 on the top of the bottle. The closure comprises a circular glass disc 66 that is adapted to sit on the sealing surface 67 on the top of the neck 12 of the bottle, a spring steel dished washer 130 and a cap 131. The cap is stepped and has a central aperture 132 bounded by an internal flange 133. The spring washer 130 locates between the top of the disc 66 and the underside of the in turned flange 133. The cap 131 has a lower rim 134 terminating in four equally spaced inwardly facing lugs 138 that as shown in Figure 8(b) engage the coarse thread 63 on the neck of the bottle. In this embodiment, as the cap 131 is turned through a quarter or half a turn on the coarse thread 63 on the neck of the bottle, it is pulled down onto the neck of the bottle and the dished washer 130 is pressed flat to further urge the sealing disc 66 into positive engagement with the upper surface 67 of the bottle to assume the assembled/sealed configuration as shown in Figure 8(b).

In the embodiment shown in Figures 9(a), 9(b) and 9(c) the bottle 11 has a similar neck portion 12 to the embodiment shown in Figures 8, namely with provision of an

annular land 65 and external coarse thread 63 with the sealing surface 67 provided at the top of the bottle. A metal or plastics cap 200 has a central aperture 251 and a lateral rim 252 terminating in inwardly facing lugs 253 like the embodiment of Figure 8 which enable the cap 250 to be screwed onto the neck 12 of the bottle in the same manner as the previous embodiment. The top of the cap has an internal spring steel lip 254 that replaces the separate spring washer of the embodiment of Figure 8. The in turned lip 254 can be axially compressed to provide a degree of axial load on the sealing disc 260 in the assembled view shown in Figure 9(b). In this embodiment the flat sealing surfaces are held in compression by the pull of the cap on the coarse thread and the resilience of the inturned lip 254 on the top of the cap 250. The disc 240 is a slightly different configuration having a lower annular sealing surface 261 with a raised central section 242. The top of the disc 260 has an annular surface 264 on which the spring lip 254 of the cap 250 engages and a slightly raised central section 265 at the top of the disc 240. As shown in Figure 9(c), the disc includes three equally spaced projections 266 around its periphery. The effective diameter of the projections 266 is greater than an inwardly projecting rib 257 on the cap 250 such that the disc 240 can not fall out of the cap 250, thus ensuring that the disc 240 is held captive of the cap 250 even when the closure is off the bottle. The top of the cap 250 also has three radial slits 259 to increase the inherent spring capacity of the cap.

A further safety feature shown in Figure 9(b) is the provision of an outer tape seal 270 that wraps around the annular rim 252 on the neck of the bottle and the underside of the cap. The tape seal 270 can, if necessary, extend to the top of the cap 250 and provides a tamper proof indication that the closure has not been used. To open the closure the tape seal 270 must first be

removed from the closure and then the closure can be released by a quarter or half turn which causes the cap 250 to spring up from the neck of the bottle and releases the seal 240.

In the embodiment shown in Figures 9(c) the same assembly is illustrated except that the sealing disc 280 includes a central porous insert 281 that is introduced to provide a degree of breathability through the seal. A rubber, cork or other slightly resilient membrane 282 is located in an undercut groove 283 in the underside of the seal 280 and sits on part of the sealing surface 67 of the neck of the bottle to provide a degree of cushioning to prevent the seal breaking through vibration. The membrane 282 also acts as a backup seal especially in the event of faulty sealing surfaces. In the embodiment shown in Figure 9(d) the anti-vibration ring or membrane 282 is of rectangular cross section. It is however understood that it could be of circular or other cross sectional shapes. The porous insert 281 is preferably positioned in the seal disc 280 during the moulding process in which the seal disc is produced.

In the embodiments that utilise coarse threads to secure the sealing member the seal can be effected or released by about a quarter turn.

In the embodiment shown in Figures 10(a) and 10(b), the closure 180 comprises a disc shaped seal 181 that seats on the upper surface of the neck 12 of the bottle 10. A metal, plastics or ceramic cap 182 sits over the to of the neck of the bottle and includes a central aperture 183 in the top of the cap 182. The cap 182 has a downwardly extending skirt 190 defined by arcuate fingers 189 as shown in Figure 10(a). The exterior of the neck 12 of the bottle includes an annular outwardly projecting land 184 and an outer collar 185 fits over the

cap 182. In use, the collar 185 is pushed down over the cap 182 to assume the closed sealed position shown in Figures 10(c) and 10(d). The end of the skirt 190 of the cap defines an inwardly turned lip 187 that engages on the underside of the land 184. The collar 185 has a rectangular cutout 188 and the periphery of the skirt 190 has projections 191 that flex outwardly as shown in Figure 10(d) to engage within the cutout 188. Thus, in the position shown in Figure 10(d) the interface between the projection 191 and the slot 188 prevents the outer collar 185 from being pulled up. A wave washer 194 sits between the underside of the cap 182 and the top of the disc seal 181 to, when in the position shown in Figure 10b, urge the seal 181 into parallel contact with the upper surface of the wine bottle to effect the seal. To release the seal the outer collar 185 is turned through a quarter of a turn that has the effect of causing the inner surface of the collar to press down the projection 191 allowing the collar to slide upwardly. This then allows the cap to be pulled off the top of the neck of the bottle and releases the pressure on the seal 181 to break the seal and release the contents of the bottle. In the open unsealed configuration, shown in Figures 10(a) and 10(b), a tab 195 formed on the skirt 190 of the cap 182 springs inwardly to engage against the underside of the disc 181 to prevent the disc 181 and washer 194 from falling out of the cap 182. The closure can thus be resealed by simply pushing down on the outer collar 185 to cause the in turned lip 187 of the skirt 190 to again clip under the base of the land 184.

In the embodiment shown in Figures 11(a) to 11(d), a similar closure is provided except that in this case the interior of the upper surface of the cap 200 has a series of spaced downwardly extending in turned fingers 201 that act as a spring member to, as shown in Figure 11(d), urge the sealing disc 181 into parallel contact

with the upper surface of the neck 12 of the bottle 10. This embodiment also includes an external collar 185 that pushes down on the exterior of the bottle with a lip 187 on the skirt 190 of the cap 200 springing into engagement with the underside of the land 184 on the exterior of the bottle neck. The resilient fingers 201 formed on the interior of the aperture of the cap 200 provide the resilience that causes the sealing compression of the sealing member 181 on the sealing surface defined at the top of the bottle. As the collar 185 is pulled up to the position shown in Figure 11b the spring force is relieved thereby releasing the seal. Pushing the collar 185 back down onto the cap 200 again places the seal in compression and reseals the bottle. This embodiment may also include means to locate the disc 181 within the cap 200 when in the open unsealed configuration of Figure 11(b).

In the embodiment shown in Figure 12 the closure comprises a sealing disc 231 that sits in parallel abutting contact with the top surface of the neck 12 the bottle 11. The abutting surfaces of the disc 231 and the bottle have the desired surface finish to produce the seal and the assembly is held in position by a wire frame 233 that is similar to the wire used on conventional champagne corks. The frame 233 pulls the disc 231 into axial compression and can be released by undoing the rim 234 of the frame 233 that sits under an external rim on the neck 12 of the bottle 11. Once the wire frame 233 has been removed, it is a simple matter to either laterally or axially displace the sealing disc off the top of the bottle thereby releasing the contents.

Still wine usually has the capacity of resisting internal pressures of 140kPa (20psi). Thus, the closures to wine bottles are usually designed to resist internal pressures of 170kPa (25psi). The closures described provide vent resistance of 200-350kPa (30-50psi). With a

bottle neck having an internal diameter of 19mm the force required to hold a sealing member at an internal pressure of 140kPa is 40N (4kg) whilst at a pressure of 350kPa it would by 99N (9.9kg). The maximum acceptable extraction force for a cork closure is usually 450N (45kg).

In all of the seals described above, the optically flat contact between the sealing member and the sealing surface can provide an airtight seal. This is in contrast with more conventional corks where a certain degree of breathing is allowed, allowing air to enter the space between the top of the wine and the end of the cork. There are many in the wine industry that view this entry of air as being crucial to enhance the ageing of the wine. If seals of the kind described above are to be used with wine of that type where a degree of permeation of oxygen is required then it is understood that the sealing member could have an inherent degree of porosity that provides this access to oxygen.

The capacity of the closure to permit entry of air can be controlled not only by the material of the sealing disc but by the quality of the sealing surfaces. A rougher, less smooth and flat surface could be used to prevent liquid escape yet allow a controlled degree of air entry. In a further option the sealing disc, preferably in glass, can include a plug of porous material with its porosity and cross section controlled to provide the desired air entry. In this manner the closure of this invention can allow wine to age in the same manner as cork without the possibility of cork contamination. In embodiments where porosity is controlled by the seal and anti-vibration membranes are included it is understood that they too would have a degree of porosity to allow passage of air. Where the sealing disc is porous or includes a porous plug the closure could comprise a series of such discs superimposed one on the other. The porosity

could thus be selectively varied by removing one or more of the discs to vary the rate of air passage. The cap could be designed to allow removal of one or more discs without disturbing the actual seal.

The combination of the abutting flat surfaces and the axial pressure therebetween coupled with the geometry of the closure preventing lateral or shear movement between the surfaces ensures a positive and generally airtight seal that can last for many years and withstand the shocks, loads and other distorting criteria that can come from vibration, noise and temperature fluctuations.

It is understood that in some circumstances the closures discussed above may be applied in a zone of partial vacuum to remove air from the top of the bottle.

It is furthermore understood that the invention is not limited to wine bottles. The closures may be used on many other types of containers for liquids, powders or pastes.

In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprise" or variations such as "comprises" or "comprising" is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.